APPLYING WEPP TECHNOLOGIES TO WESTERN ALKALINE SURFACE COAL MINES

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Introduction

- A key aspect of planning surface mining operations, regulated by the US National Pollutant Discharge Elimination System (NPDES), is to estimate potential environmental impacts during mining operations as well as the reclamation period that follows
- Practical computer simulation tools are effective for evaluating site-specific sediment control and reclamation plans for the NPDES

Goal

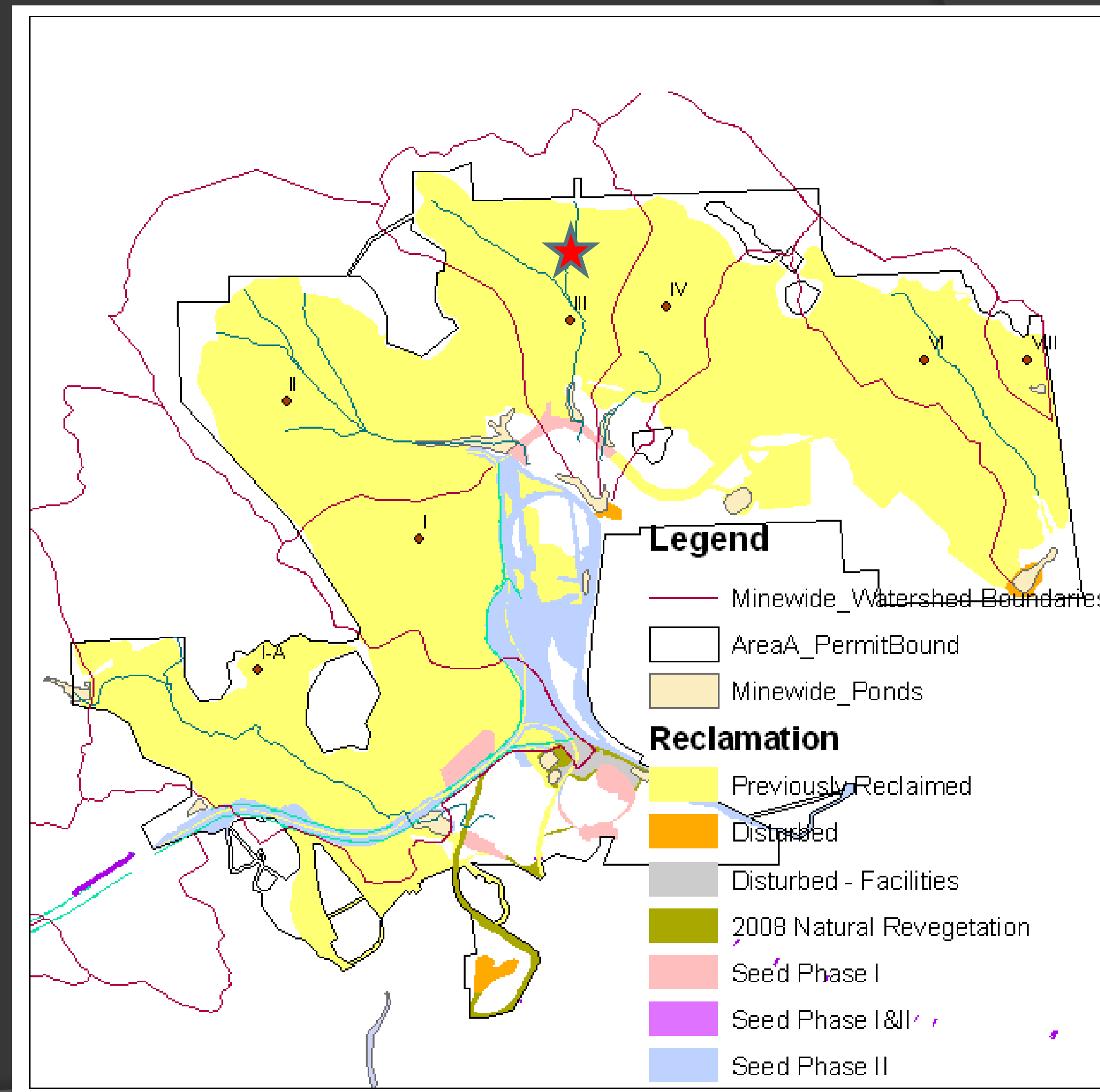
- To adapt WEPP (Water Erosion Prediction Project) for evaluating cumulative watershed hydrological responses and spatial variations of soil detachment and deposition as affected by Best Management Practices (BMPs) for erosion control at Western Alkaline Surface Coal Mines

Objective

- To apply WEPP technologies to a representative Western alkaline surface coal mine to assess the effectiveness of selected BMPs for erosion control

Study Site

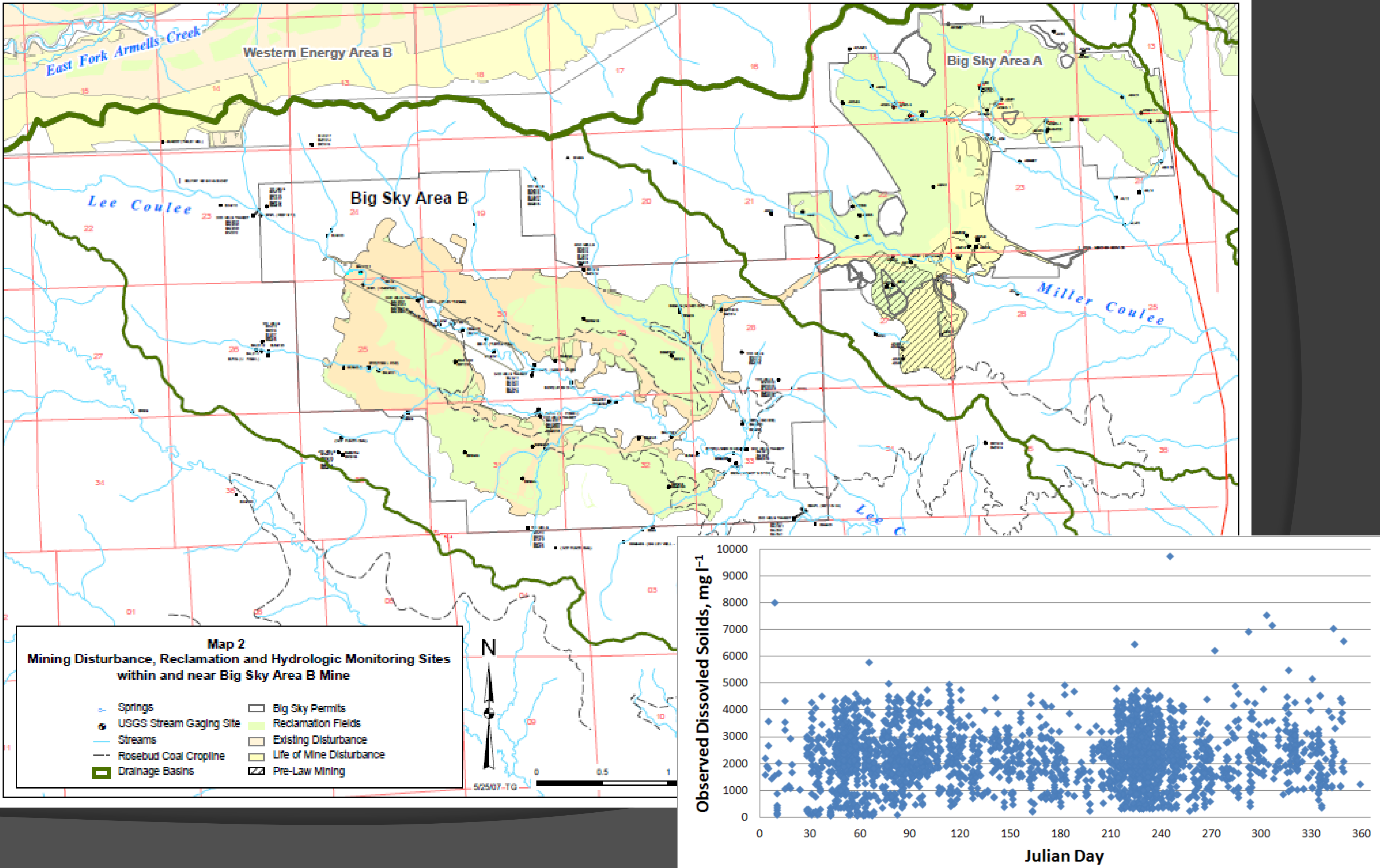
- Watershed III in Area A, Big Sky Mine, a major surface coal mine in southeast Montana State, USA



Area A: Big Sky Mine

- Mining of the area completed in 1989
- Most reclamation activities, including regrading, topsoil replacement, and revegetation of the mined areas, were completed in 1992
- A number of watersheds in Big Sky Mine have been monitored for channel flow and water quality Since 1984

Field Observations

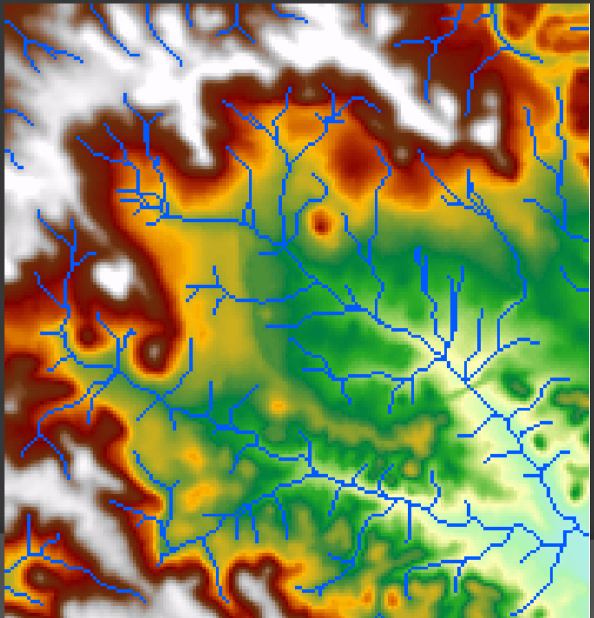


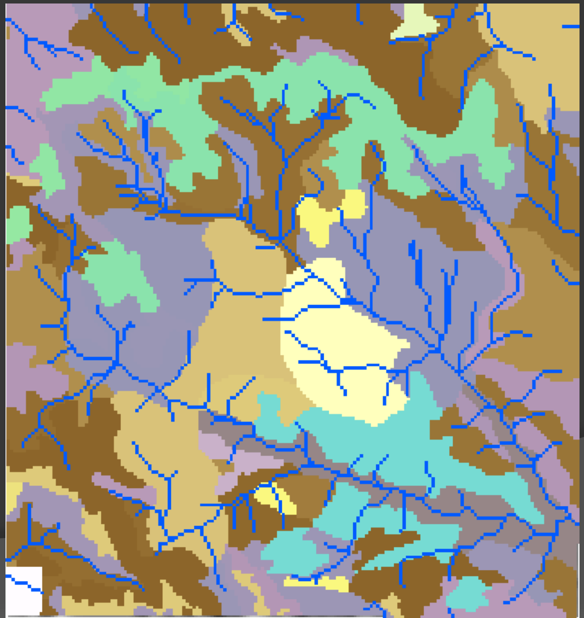
WEPP Simulations

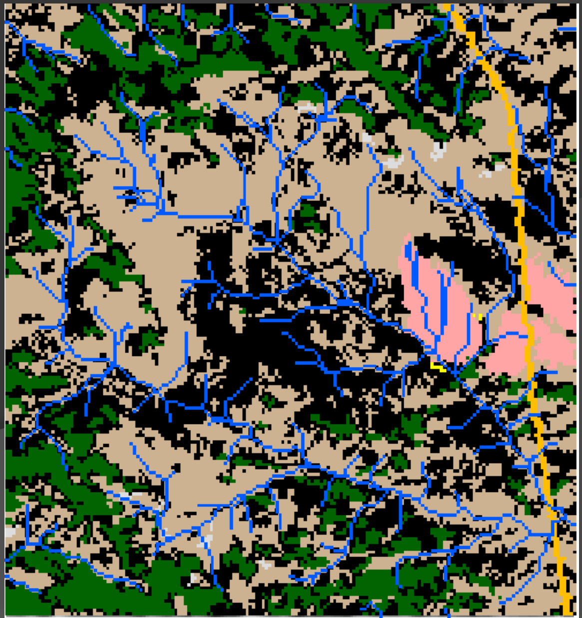
- Three management practices: revegetation, sediment pond, and silt fence, were chosen; and four scenarios were simulated:
  - Premining condition as a baseline against which other scenarios are compared
  - Postmining with revegetation
  - Postmining with revegetation and a sediment pond
  - Postmining with revegetation and a silt fence

Inputs: Premining

- Topography: the earliest DEM data available
- Soil: NRCS SSURGO
- Landuse: USGS National Land Cover dataset
- Soil and management data were acquired using the online WEPP GIS interface

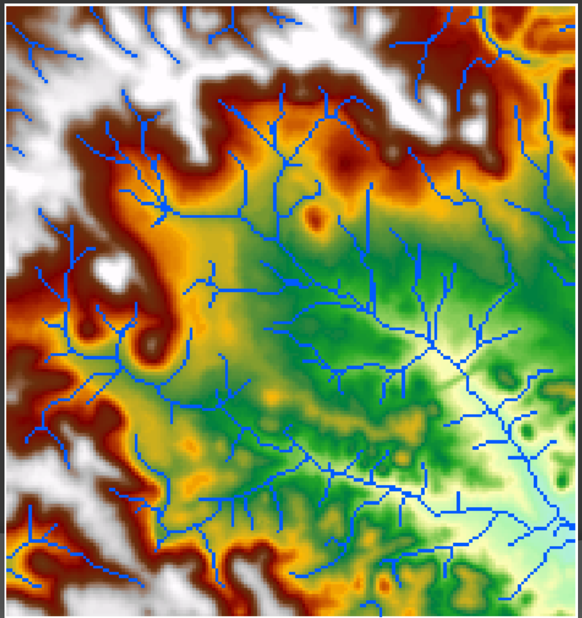


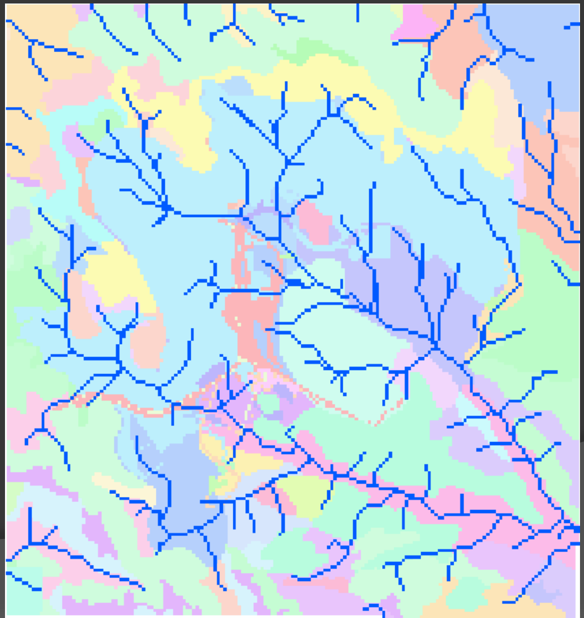


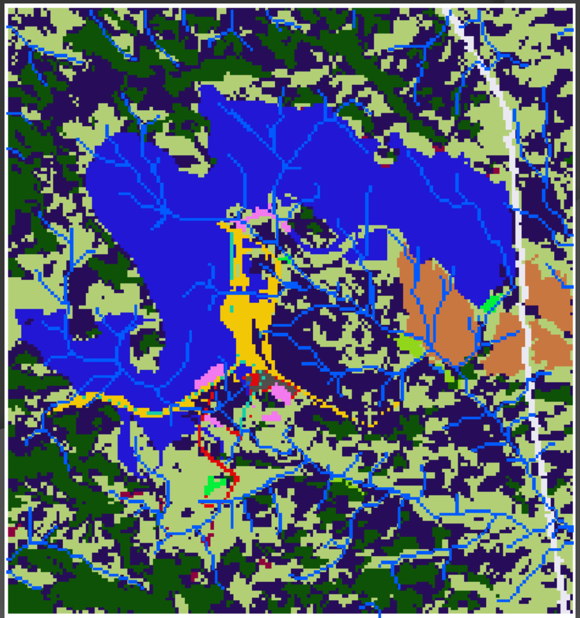


Postmining with Revegetation

- Topographic map taken from the Big Sky Mine 2008 Ann. Rep. to MT DEQ
- Soil and management data for disturbed areas from Reclamation and Bond Status Rep. to MT DEQ
- Soil and management data developed from field observations and assessments

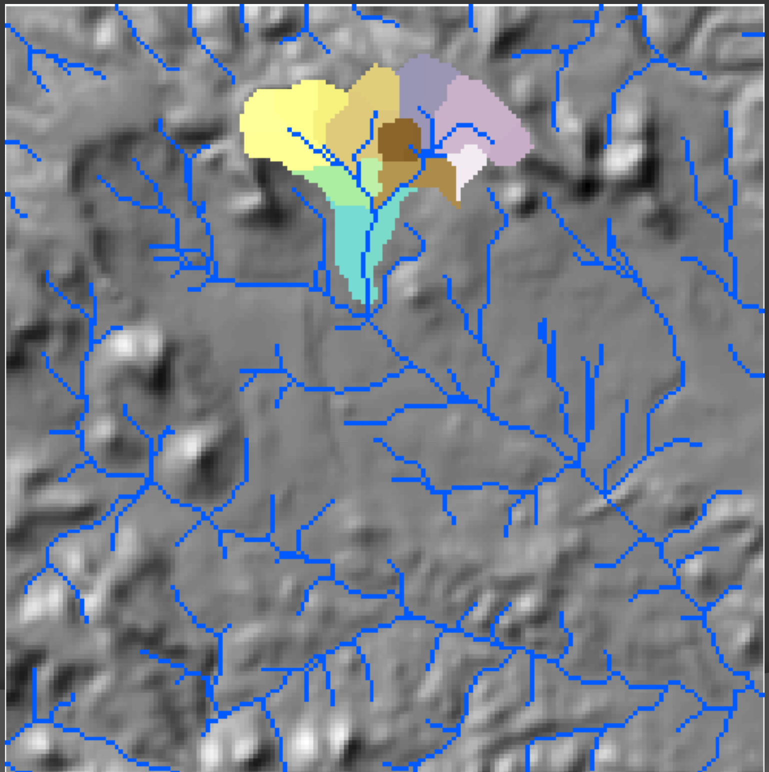


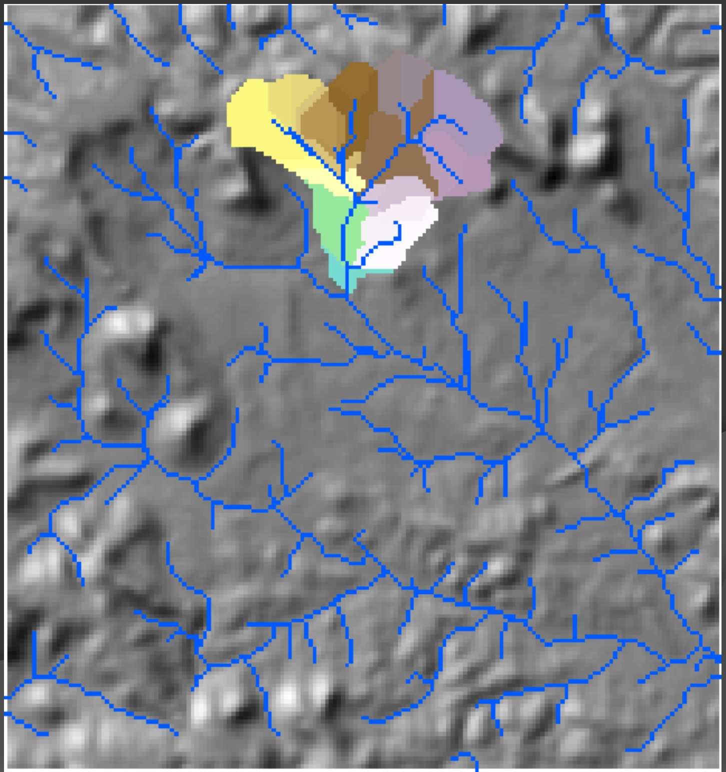




Watershed Delineation: Pre- vs Postmining

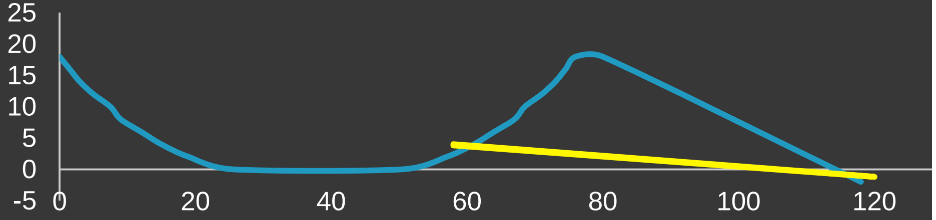
- Topographic, soils, landuse, and management conditions vary between mining and postmining periods and differ from natural, premining conditions

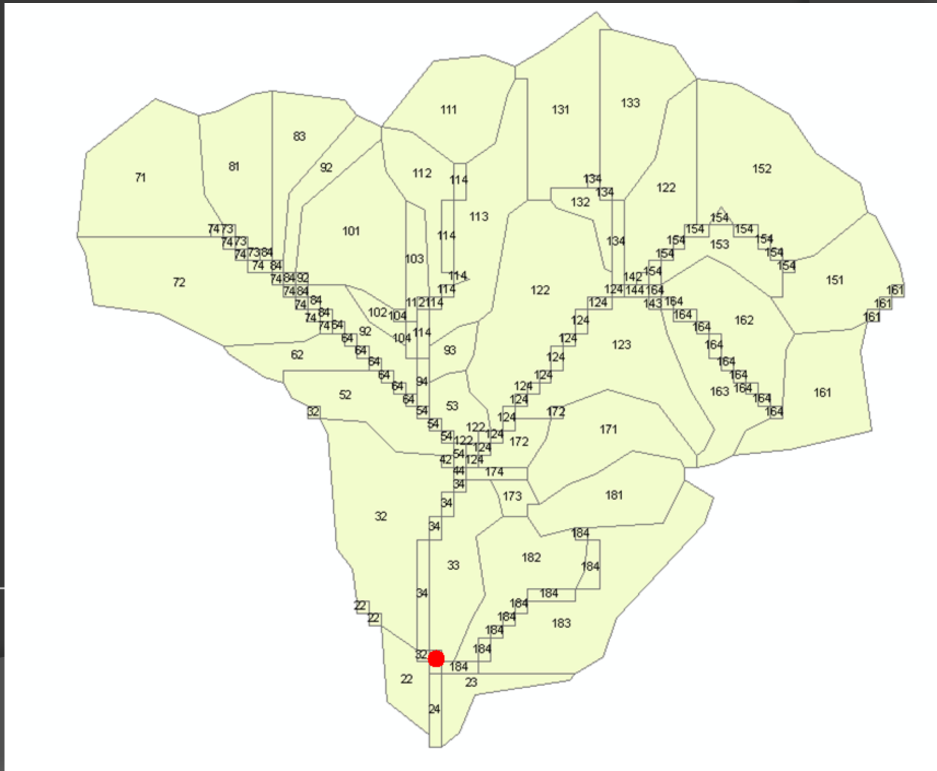




Sediment Pond

- Situated near the outlet of the watershed
  - 60,000 m^3 in volume
  - A culvert 2.4 m above bottom, with 18-cm i.d.

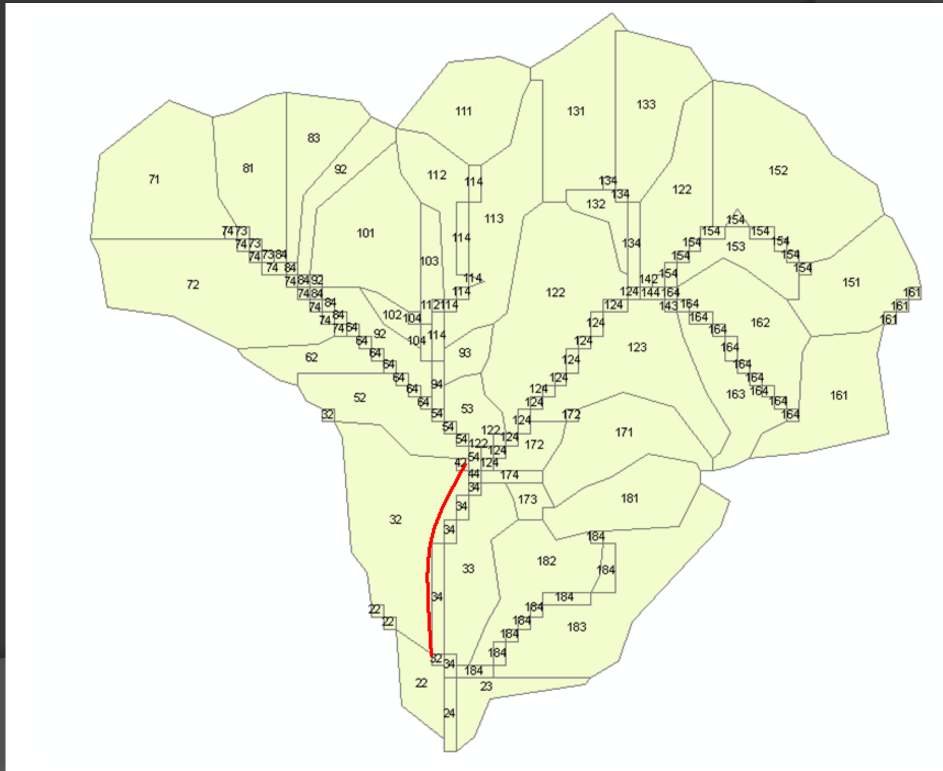




Silt Fence

- Located on the toe of a hillslope near the watershed outlet with 1-m fence height

Curtsey: USDA Forest Service
Rocky Mountain Research Station, Moscow, Idaho



Return-period Analysis

- Return-period analyses were performed on field observations and WEPP simulations
  - WEPP simulations for 25 yr were made using observed precipitation and temperature for 1984–2009 from Colstrip climate station (5 mi NW to study site) and the remaining climatic inputs generated using CLIGEN
  - Runoff and sediment yield of WEPP-simulated events with a return period of 2, 5, 10, or 20 yr were compared with the field observations

Return-period Analysis

- Return periods were estimated using Chow's frequency factor method and Gumbel's distribution with an annual maxima series following Patra (2000)

$$X_T = X_m + s_x \cdot K$$

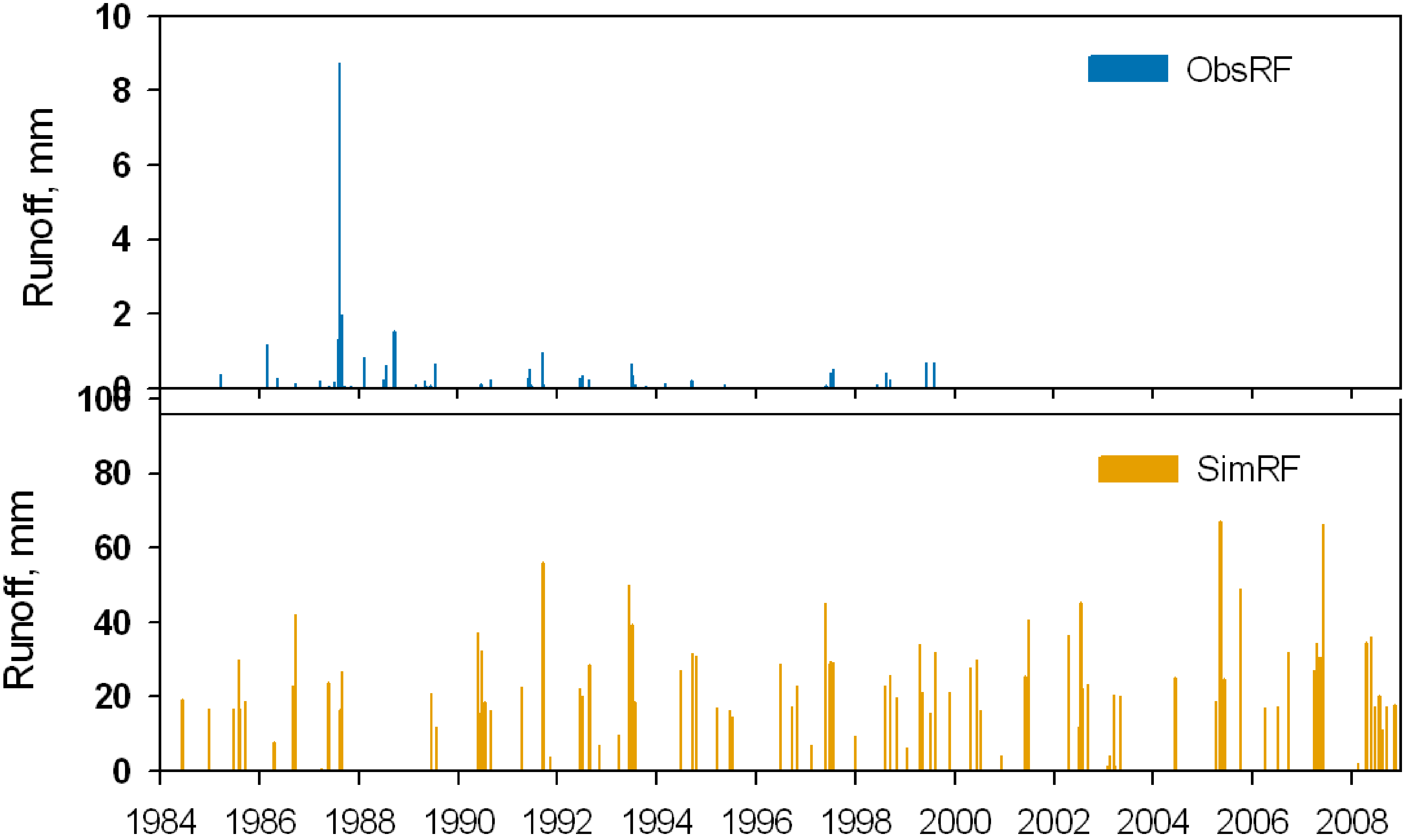
$$K = -(0.45005 + 0.7797 \ln(\ln(T/(T-1))))$$

T: specified return period

X_T: estimated value for a return period T

X_m, s_x: mean and standard deviation for the annual maxima of the events

Results



10
8
6
4
2
0
Runoff, mm
ObsRF
100
80
60
40
20
0
Runoff, mm
SimRF
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008

Results cont'd

	Runoff, mm					Sediment Yield, kg ha^{-1}			
Return Period (yr)	2	5	10	20		2	5	10	20
Field-observed	0.7	2.3	3.3	4.3		0.8	2.0	2.7	3.5
WEPP-simulated									
Premining	2.7	6.8	9.5	12.1		1200	3000	4100	5200
Postmining+Revegetation	6.8	15.9	21.9	27.7		7600	20300	28700	36700
Postmining+Sediment Pond	6.1	15.0	21.0	26.7		3300	10800	15700	20400
Postmining+Silt Fence	6.8	15.9	21.9	27.7		6700	17800	25200	32200

Results cont'd

- WEPP simulations overestimated observed runoff and sediment yield; however, the simulation results showed the effectiveness of the sediment control practices
- A silt fence at the watershed outlet helped to reduce sediment yield only slightly from the postmining revegetation condition
- A sediment pond seemed more effective, reducing sediment yield by half

Summary

- The WEPP model was applied to a watershed the Big Sky Mine, Montana State, USA, to assess surface runoff and erosion as impacted by surface coal mining activities and postmining reclamation and sediment control practices
- Three commonly used BMPs: revegetation, sediment pond, and silt fence were evaluated as postmining reclamation management practices
- WEPP simulation results demonstrated the effectiveness of the sediment control practices with sediment pond being the most effective
- Currently, we are
  - Conduct in-depth analyses of field data
  - Parameterize WEPP with field soil and ground cover data
  - Developing and incorporating functions in the Online WEPP GIS Interface for mining applications

Thank You!

Questions?